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## Biological and Environmental Influences on the Cognitive Development of Children with Developmental Disabilities

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BIOLOGICAL AND ENVIRONMENTAL INFLUENCES  
ON THE COGNITIVE DEVELOPMENT  
OF CHILDREN WITH  
DEVELOPMENTAL DISABILITIES

BY  
RUTH H. SCHENNUM

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF  
THE REQUIREMENTS FOR THE DEGREE OF  
DOCTOR OF PHILOSOPHY  
IN  
PSYCHOLOGY

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## ABSTRACT

The biological and environmental influences on sensorimotor/cognitive development were studied. Participants were 100 children with developmental disabilities between the ages of 2 and 28 months and their families. Scores from the Rochester Research Obstetric Scale (ROS), Pediatric Complications Scale (PdCS), and Home Observation for the Measurement of the Environment (HOME) were used as independent variables in a multiple regression analysis. The dependent variable was the Mental Development Index (MDI) from the Bayley Scales of Infant Development. Results indicate there is a significant, but moderate relationship between the independent and dependent variables. Very little overlap was found among the independent variables. Total explained variance in MDI was 28%. Pre-, peri- and postnatal factors, measured by the ROS, contributed a negligible amount to this variance. Medical problems (PdCS) experienced after the neonatal period contributed 58% to the variance in MDI, while the HOME contributed 42%. The bivariate relationship between PdCS scores and MDI was inverse, indicating that higher scores on one are associated with lower scores on the other. The

relationship between HOME scores and MDI was positive, meaning higher scores on one are associated with higher scores on the other. Caution is given regarding efforts to generalize or operationalize this multiple regression system.

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## CHAPTER I

### Introduction

#### Biological Influences

In recent years a considerable amount of attention has been focused on the development and implementation of biomedical techniques for sustaining the lives of infants with a variety of medical problems resulting from pre-, peri-, or postnatal complications which are presumed to cause an infant to be at risk or have an established risk for development disabilities. Prior to this time, the efforts to reduce infant mortality had been aimed at the control of infectious diseases, since 200 out of every 1,000 children born 75 years ago in the United States could be expected to die from disease during the first year of life. Due to these large scale efforts, a major reduction in both natal and postnatal deaths have occurred such that by 1976 the mortality rate was 15.2 per 1,000 live births in the United States. A closer look at these statistics, however, revealed that 72% of these deaths occurred within the first 28 days of life, 85% of which occurred within the first 7 days; and of those occurring within the first 7 days the majority occurred within the first 24 hours of life. Over half of

all deaths under 20 years of age happen during the first year of life (Vaughan, McKay and Behrman, 1979).

With the introduction of antibiotics to control infectious disease and improved understanding of the relationship of nutrition and sanitation to both prevention and treatment of acute and chronic diseases, the field of pediatrics was able to divert its attention to medical conditions with relatively low incidence rates, e.g., developmental disabilities.

Initially this attention resulted in studies which attempted to establish causal relationships between certain prenatal, perinatal or postnatal events and specific disabilities.

Because Down syndrome, or Mongolism as it was called, was the single syndrome accounting for the highest incidence of mental retardation, many scientific investigations were devoted to determining its etiology. From these studies, it was discovered that the probability of having a child with Down syndrome increased dramatically with the age of the mother. This finding coupled with the observation that many of the body's systems were involved in this syndrome led to the hypothesis that whatever the cause, it had its impact early in embryonic development. Evidence from studies of concordant identical twins implicated a genetic factor.

According to Robinson and Robinson (1965), "Lejeune Gautier, and Tarpin (1959) are credited with first publishing the discovery of extra chromosomal material in the cells of mongoloid individuals" (p. 104).

Stimulated by the success of Lejeune et al., innumerable studies were conducted which were successful in establishing the relationships between disruptions occurring early in embryonic development and subsequent development. The gene-based disorders such as galactosemia, maple syrup urine disease, Hurler's syndrome, genetic thyroid defects and phenylketonuria are examples of conditions which in their untreated states are associated with retardation (Kopp & Parmalee, 1979).

As progress was being made in the prevention, identification and, in some cases, treatment of the gene and chromosomal based disorders, investigations were turning toward infants with congenital anomalies who had survived insults directly to the central nervous system, e.g., spina bifida. Because this insult had to occur early in embryonic development as it did in the gene and chromosomal-based disorders in order to have a direct impact on the central nervous system, assumptions were made that subsequent fetal development would be deleteriously effected. Following the lead of previous

research, attempts were made to isolate a specific genetic or chromosomal mechanism which would explain this disruption in development, but no one mechanism was found. As a result, it is currently accepted knowledge that many parents may carry genes which make them susceptible to environmental factors, e.g., drugs, X-Rays, viruses, etc. known to have some association with malformations (Blackman, 1983); and that through the complex process of multifactorial inheritance, interactions occur which produce trauma to the developing central nervous system. Hence, research efforts turned to looking for particular clusters of genetic and teratogens which could explain disruptions in central nervous system development. None have been found.

Due to advanced technologies in prenatal diagnosis, it is now possible to identify "myriad chromosomal disorders and well over 100 inborn errors of metabolism . . . by means of amniocentesis. In addition, numerous structural abnormalities have been identified through the use of ultrasound, various radiographic techniques, fetoscopy, and assay of maternal serum or amniotic fluid  $\alpha$ -fetoprotein" (Burney, Walker & Dumars, 1985, p. 2). Since approximately 3 to 5% of all infants born in the United States have a significant birth defect or genetic disorder, prenatal diagnosis has

the potential for early identification and intervention with those groups with established risk of certain developmental disabilities.

The implications of these procedures for the future are awesome, especially in view of Baumeister's (1981) report on surveys of physicians' attitudes regarding the treatment of children with Down syndrome in life threatening conditions. In one survey, only 17% of the physicians indicated that they would want the parents to do "everything humanly possible to preserve the infant's life" (p. 453).

Although neonatal mortality has decreased significantly in the past 75 years, it still accounts for almost 40% of the deaths under the age of 1 year (Glasgow & Overall, 1979). Thus, the first four weeks of life are a very critical period and have demanded increased consideration from the pediatric community.

Rapid progress in the field of neonatology has resulted in the development of extraordinary techniques aimed at the reduction of infant mortality and morbidity. Several groups of infants who have been the primary recipients of these advancements have been those who were either born prematurely and/or those who are considered small for their gestational age. That tremendous concern would be directed toward these groups

of infants is not surprising in view of Glasgow & Overall's (1979) observation that:

for any given duration of gestation, the lower the birth weight, the higher the neonatal mortality, and, for any given weight, the shorter the duration of gestation, the higher the neonatal mortality. The highest risk of neonatal mortality is among infants who weigh less than 1000 gm at birth and whose gestation was less than 30 weeks (p. 400).

Because the conditions of prematurity and/or low birth weight themselves were thought to be necessary and sufficient to explain later developmental problems, amelioration of these conditions became a priority. In terms of morbidity, Drillien (1964) reported that after a 5 year follow-up of infants born with birth weights of 1360 gm or less, 78% were below the 5% percentile in weight, height or both; 91% had IQ's below 100; and 71% were either uneducable in a normal school or required special treatment in a normal school.

In the perennial search for the etiologies of prematurity or the small for gestational age condition, it became apparent that there were a number of medical conditions, e.g., toxemia, incomplete cervix and

placental problems, which could account for about one half of these conditions. But, most importantly, a positive correlation was discovered for both the conditions of prematurity and small for gestational age with socioeconomic status (Drillen, Thomson, & Burgoyne, 1980).

With the increase in infants surviving the neonatal period who were considered an established risk or at risk for developmental disabilities, researchers became interested in following the developmental progress of these infants and engaged in outcome research studies.

In an attempt to discover the linkages between obstetrical complications, or at risk conditions, and later disabilities, Pasamanich and Knobloch (1966) undertook extensive retrospective studies. They concluded that at least two factors, anoxia-producing complications and/or prematurity, were associated with later developmental disabilities which included cerebral palsy, epilepsy, mental retardation, autism, dyslexia and hearing impairment. An unexpected finding was that "prematurity and pregnancy complication rates increased exponentially below certain socioeconomic thresholds" (p. 19).

Subsequently, numerous investigations were undertaken to prospectively evaluate the effects of each



of these medical complications with the goal of defining the risk factors which "cause" a wide range of handicapping conditions. The results have been disappointing from a biological perspective. For example, after a review of studies dealing with the long-term effects of anoxia, Sameroff and Chandler (1975) concluded, as did Gottfried (1973), that "anoxic subjects as a group are not mentally retarded and that whether anoxic subjects are deficient in specific intellectual abilities is not yet known" (Sameroff, 1979, p. 120).

Conclusions regarding the impact of prematurity on later intellectual status could not be as succinctly summarized, possibly because of the difficulties in studying a group that is so heterogeneous. Due to the confounding problems often associated with prematurity (e.g., intrauterine growth retardation, intraventricular hemorrhage, respiratory distress, bronchialpulmonary dysplasia) which require extensive treatment and prolonged hospitalization (Landry, Fletcher, Zarling, Chapieski, & Francis, 1984), controlled studies are very difficult to conduct. Kopp and Parmelee (1979) state that "examination of studies of older pre-terms lead to no definitive conclusions, but some studies show term and pre-term differences in functioning. . . . the number and type of

differences are far fewer than those obtained in the newborn period" (p. 53). In a recently published study (Landry, et. al., 1984) of low birth weight, preterm infants, it was demonstrated that length of hospitalization may be a more important factor influencing developmental outcome than prematurity itself.

With the realization that prematurity and small for gestational age were multifarious conditions, investigators attempted to relate a particular aspect of prematurity and low birth weight to outcome measures. For example, one of the most frequent and greatest liabilities of survival for a neonate weighing less than 1500 grams and/or born before 35 weeks of gestation is a periventricular or intraventricular hemorrhage (IVH) within 48 hours of delivery. Outcome studies relating neurological and/or developmental sequelae to IVH include the following measures: degree of hemorrhage only (Krishnamoorthy, Shannon, DeLong, Todres, & Davis, 1979); low birth weight and grade of hemorrhage (Williamson, Desmond, Wilson, Murphy & Garcia-Prats, 1983; and Naulty, Gaiter, Chang, Eng, Murray, Reutter & Horn, 1983); cerebral flow measurements (Ment, Scott, Lang, Ehrenkranz, Duncan & Warsaw, 1983); degree of prematurity and intraventricular hemorrhage (Palmer, Dubowitz, Levene & Dubowitz, 1982); presence of intraventricular

hemorrhage and hydrocephalus (Shankaran, Slovis, Bedard & Poland, 1982); and states of intraventricular hemorrhage and coma (Robinson & Desai, 1981). The results are confusing and often contradictory with developmental and neurological outcome correlated to degree of hemorrhage in some studies (Krishnamoorthy, et al. 1979 and Williamson, et al. 1983); maturity, not size of hemorrhage, the main factor affecting mortality and morbidity in others (Robinson & Desai, 1981); the presence of post-hemorrhagic hydrocephalus rather than the size of the hemorrhage itself (Palmer, et al. 1982) and both grade of hemorrhage and birth weight correlated with the need for special education (Williamson et al., 1983). Most noteworthy is the finding that this last study (Williamson et al., 1983) was the only one which attempted to relate other than biological variables to outcome. "Intellectual performance was related not only to grade of hemorrhage and birth weight, but also to paternal social class (p.1181)."

In an attempt to improve upon the predictive power of biological variables in accounting for later intellectual status, some researchers have used combinations of pre-, peri- and postnatal factors. For example, Littman and Parmalee (1978) have demonstrated significant relationships between a combination of

medical events and the Bayley Mental and Motor Scales at 18 months for a group of pre-term, low birth weight infants. Nevertheless, only a small amount of the variance in mental and motor scores was accounted for, approximately 5%.

Outcome studies, which parallel those described earlier for the "at risk" populations, are those follow-up studies concerned with the outcome of infants with established risks for developmental disabilities.

Centerwall and Centerwall (1960) conducted a study comparing two groups of children with Down syndrome. One group had been reared in their own homes until 4 years of age before placement in an institution and the other had been placed in an institution or foster home just after birth. The groups showed statistically significant differences in their intellectual functioning. However, both groups demonstrated extreme degrees of retardation. Consequently, textbooks published during the 1960's typically stated that "the degree of mental retardation is usually in the severe and moderate ranges" (Robinson & Robinson, 1965, p. 99), and parents of children with Down syndrome were told that their child would learn little from teaching and only a few would pass the second grade (French and Scott, 1967). Institutionalization of Down syndrome children was seen as the only alternative by

many (Doris & Sarason, 1969). The prevailing notion was because children with Down syndrome have a common etiology for their disability, their developmental outcome should be relatively homogeneous.

Bayley, Rhodes, Gooch and Marcus (1971) compared the abilities of infants with Down syndrome reared at home with a comparison group of similar infants reared in an institution. They found that children raised at home had a mean Bayley Mental Development Index (MDI) of 56 while those in the institution had a mean MDI of 35; these differences were statistically significant. In 1973, Smith & Wilson demonstrated a great deal of variability in the IQ's of Down syndrome children, ranging from 20 to 70 points.

Another group of disabled youngsters whose development was thought to be relatively immutable to the effect of the environment were children with spina bifida. The recency of this thinking is evidenced by an article published in 1983 (Gross, Cox, Tatyrek, Pollay and Barnes) entitled "Early management and decision making for the treatment of myelomeningocele," which is a form of spina bifida. The article advocates the use of selection procedures in determining which infants should receive vigorous treatment versus supportive treatment. The outcome of supportive care in this study was death.

As with many of the studies reviewed thus far, much of the research concerned with spina bifida has centered around prospective and retrospective studies attempting to relate degree of severity of physical involvement, e.g., type of lesion, presence of hydrocephalus, lacunar skull deformity, etc., to later developmental status. A study by Lonton, Barrington, & Lorber (1975) indicated that the differences in IQ at age 5 or older between children with various degrees of severity were not large. Eighty two percent of the children with the greatest amount of lacunar skull deformity had IQs above 70.

A controlled study in 1977 by Soare and Raimoni of children with myelomeningocele some of whom also had shunted hydrocephalus indicated that 63% of children with myelomeningocele and shunted hydrocephalus had IQs above 80 while 87% without hydrocephalus had IQs above 80. An incidental finding was that the IQs of these subjects was related to family income and educational levels.

The main themes throughout the studies reported in this section have dealt with the biological influences on development in terms of the search for specific etiologies for particular developmental disabilities; and the establishment of relationships between categorical classes of developmental disabilities and outcome measures.

## Environmental Influences

There is a paucity of research dealing with the environmental influences on young children at risk or with an established risk for developmental disabilities. As mentioned in the previous section, this can be partially explained by the notion that these children's level of cognitive development was predetermined as a result of their biological impairments which in turn somehow had immunized them to the impact of their environment.

Ironically, however, much of the thrust for the numerous investigations which have assessed the influence of the environment on the developmental progress of healthy infants came from the classic study of Skeels and Dye (1939). They found that an experimental group of retarded youngsters reared in an institution by retarded surrogate mothers showed a mean IQ gain of 27.5 points within a two year period while a comparison group of children remaining at an orphanage lost 26.2 points. Their conclusion was that it was possible for children's IQ to change from retarded to normal levels given appropriate environmental stimulation and nurturance. This change in status purportedly enabled the majority of the experimental group to become adopted whereas none of the controls were. In a follow-up study 25 years

later, Skeels (1966) reported that all children in the experimental group had skilled or semi-skilled jobs; whereas half of the control group remained in the institution and the other half had semi-skilled jobs.

In 1954, Jones provided a comprehensive review of the literature regarding the relationship of social class to intelligence. While controlling for parents' education and/or parental intelligence, it has been consistently demonstrated that the correlation between parental social status and their offspring's intelligence is about .50. However, the processes by which parental social status and other environmental variables actually effect their children's intelligence has only recently been addressed.

The development of reliable and valid instruments for assessing these variables is relatively new and it is now possible to make some generalizations across investigations.

In an attempt to isolate the qualitative and quantitative environmental variables that influence cognitive development, a number of predictive and concurrent studies have been conducted. The presence of age-appropriate play materials (Bradley & Caldwell, 1984; Johnson, Breckenridge, & McGowan, 1984); amount of space, lack of crowding and regularity of a routine (Wachs, 1979) have all consistently shown a positive relationship



to cognitive development in children. On the other hand, some variables have been identified which negatively correlate with children's cognitive functioning such as noise level, and number of siblings (Gottfried & Gottfried, 1984). In terms of the characteristics of the caregiver, contingent verbal responsivity to the child emerges as a critical variable in predicting later intelligence (Beckwith & Cohen; Wachs, 1984).

As with children's intelligence, parental demographics, including maternal IQ, parental education or social class have been shown to account for 25% to 50% of the variance in the home environment (McPhee, Ramey, Yeates, 1984) across a number of studies. But few studies have included these variables and assessments of the home environment in regression equations with child's level of cognitive development as the criterion measure.

Correlations between overall measures of the home environment and children's level of cognitive development tend to vary with age. During the first year, most studies report weak correlations between the two; but by the third and fourth years these relationships become much stronger. The predictive validity of using assessments of the environment during the first year of a child's life and intelligence scores obtained 5 years later shows a moderate relationship (Bradley & Caldwell, 1984).

In addition to the relationships which have been established between direct environmental influences and children's cognitive development, some researchers have attempted to relate family ecological variables, e.g., parental stresses, supports, expectations, to cognitive development. Gottfried and Gottfried (1984) have shown that positive relationships exist between family climate, i.e., cohesion, expressiveness and intellectual cultural scales at 36 months of age and concurrent levels of cognitive development.

As well documented as these influences are, on the cognitive development of the normal population, much remains to be known about their effects on children who are developmentally disabled.

### Combined Influences

Studies which have been more successful in finding linkages between data collected on neonates and developmental outcome have been those multifactor studies which have also included socioeconomic or environmental measures. The Children of Kauai study (Werner, Bierman & French, 1971) involved the collection of vast amounts of data in order to conduct a comprehensive longitudinal study of children living on the Island of Kauai. From an early report of this study on the relationship between

perinatal factors, quality of the child's home environment and physical, intellectual and social development at age 2, Werner, Simonian, Bierman and French (1967), concluded that

with increasing severity of perinatal stress, there was an increase in the proportion of 2 year olds considered to be below normal in physical status and in intellectual and social development. . . . In general, the quality of the home environment had a significant effect on both mental and social development by age 2, and the effect increased with the severity of perinatal complications (p. 504).

Subsequent examination of these children at age 10 has suggested that generally the effects of the environment on development had become even more important, with a greater number of children having difficulties related to environmental conditions rather than to perinatal conditions. In a multiple regression analysis using a perinatal stress score, Cattell I.Q. at 20 months, pediatricians' ratings at 20 months, Social Quotient at 20 months, parental education and SES, approximately 34% of the variance in I.Q. was accounted for at age 10.

(Werner, Honzik & Smith, 1968). Continuing analyses of this data have indicated that accurate predictions of significant learning and behavioral problems in adolescence could be made. According to Meier's (1976) interpretation of the data,

The following 11 items proved to be key early predictors of subsequent serious DLD's [developmental and learning disabilities]:

(1) moderate to marked degree of perinatal stress; (2) presence of congenital defects; (3) very high or very low levels of infant activity; (4) Cattell I.Q. score below 80 by age 2; (5) low Primary Mental Abilities I.Q. score; (6) moderate to marked degree of physical handicap; (7) recognized need for placement in a learning disability class; (8) recognized need for more than 6 months of mental health services by age 10; (9) low level of maternal education; (10) low standard of living at birth, age 2, or age 10; and (11) low family stability at age 2 (p. 347).

In this country, Smith, Flick, Ferriss and Sellman (1972) conducted a similar study, using multivariate techniques. They examined the capability of data relating to mother's background, obstetrical complications, pediatric evaluations, and psychological examinations collected during the first four years of life to discriminate "normals" from "abnormals" at seven years of age in a group of randomly selected Black children. They were successful in doing so with an overall hit rate of 98.4%. Close inspection of the tables resulting from the sequential analyses of discriminant functions reveals that mother's education and I.Q. were initially the most heavily weighted variables but were eventually supplanted by scores on earlier psychological tests.

Escalona (1982) investigated the interactions between biological and social factors as they related to the intellectual and psychosocial development of a group of predominantly poor, nonwhite and low birth weight youngsters from birth to 40 months of age. The results of this study showed that, overall, this group displayed normal cognitive development up through 15 months of age but by 28 months a significant decrement in cognitive functioning occurred. This decrement was closely

associated with socioeconomic status. The author inferred that ". . . environmental deficits and stresses impair early cognitive and psychosocial development for both full term and premature infants, but the latter group is more vulnerable to environmental insufficiencies than are full term babies" (p. 670).

However, the most compelling evidence in the United States for the increased predictability of intelligence test scores using familial demographic and perinatal information with children "at risk" for intellectual deficits has come from The Collaborative Perinatal Project of the National Institute of Neurological Diseases and Stroke (Nisewander & Gordon, 1972). Willerman, Broman, and Fiedler (1970) studied the relationship of Bayley Mental and Motor Scale Indices to Stanford Binet I.Q. scores at age 4 as a function of social class in a large subsample of the Project's subjects and concluded that "poverty . . . will amplify the I.Q. deficit in poorly developed infants" (p. 76). Infants retarded at 8 months were seven times more likely to obtain low I.Q.'s at age 4 if they came from lower socioeconomic status than if they came from higher socioeconomic levels. In a further analysis of this data, Broman, Nichols and Kennedy (1975) using multiple

regression techniques, found that mother's educational level and socioeconomic status were the only independent variables that made a significant contribution to I.Q. scores at age 4. No perinatal variable contributed more than 1% to the explained variance. Mother's educational level and socioeconomic status contributed 8 to 18%, with the lowest for blacks and the highest for whites. When mother's educational level, socioeconomic status, birth data and 4-, 8-, and 12-month infant assessments were included in the analysis, 28% of the variance in I.Q. at age 4 in the total subsample was accounted for.

In contrast to the many studies that have attempted to relate socioeconomic factors and/or biological variables to cognitive development, far fewer have attempted to actually specify those qualitative or quantitative aspects of the environment which may be effecting the cognitive development of children, especially biologically vulnerable children. Zax, Sameroff and Babigian (1977) initiated a longitudinal study to address these issues and were able to explain 50% of the variance in Bayley Mental Development Index scores at 30 months. They included ratings of the social

competence of the mother and observational data of the mother's behavior toward her child, gathered in the home, as well as the more traditional measures of mother's education, socioeconomic status, birth data, 4-, 8-, and 12-month assessments of the infant. Unfortunately, however, the sample was biased by the inclusion of a large subsample of women who were seeking help with emotional problems.

In a more recent study, Siegel (1981) compared the ability of infant tests to predict cognitive and language development in conjunction with assessments of the child's home environment for groups of pre-term and full-term infants. Her findings are summarized as follows:

While the correlations between infant test scores and later development are statistically significant, the infant tests accounted for, at best, 50% of the variance. Other factors are obviously needed to predict developmental outcomes. Some of the results suggest the possible importance of environmental factors.

Infants who were performing in the risk range early in development but whose subsequent development at 2 years were



normal . . . came from more stimulating environments . . . . The environment may have been one factor in overcoming their poor performance. . . . Infants who were not detected as being at risk early in development but showed developmental delay at 2 years . . . came from homes which provided less stimulation (p. 555).

Longitudinal research studies such as those being conducted at the University of Washington with a low-risk group of families (Mitchell, Bee, Hammond and Barnard, 1985) have included 4 clusters of measures: perinatal and infant status; child outcomes; family ecology and parent perceptions; and family environment and parent-child interaction. In an attempt to determine which variables are able to predict whether or not a child in the second grade would be classified as having a learning problem, extensive data analysis was conducted. It was determined that each cluster provided information not found in the other clusters, with perinatal and infant status variables contributing the least (less than 10% of the variance). Similar findings were noted for the classification of children with behavior problems except that perinatal and infant

status were not relevant. When this same data was subjected to multiple regression analyses, using I.Q. or school achievement in the second grade as the criteria, the best predictors were found to be child outcome variables, e.g., 48-month Stanford-Binet I.Q. Perinatal and infant status did not predict either I.Q. or school achievement. The ecological cluster and environment/interaction cluster showed significant relationships to achievement and I.Q. One of the salient findings was:

the generally more vulnerable children who were reared in a less optimum cognitive environment had a greater probability of later learning problems. Note that a poor environment alone was not associated with significant problems in this group of children; it was the combination of heightened physical risk and poor environment that mattered (p. 129).

### Hypotheses of This Study

After a thorough review of the literature, no study was found which investigated the combined impact of biological and environmental variables on the concurrent level of sensorimotor/cognitive development in an already diagnosed group of young children who have developmental disabilities.

The design of this study was guided by this need and by the hope that as a result more informed decisions could be made in the prevention and treatment of developmental disabilities. In this nonexperimental research, the relationships among pre-, peri- and postnatal variables; physical development; characteristics of the home environment; and level of sensorimotor/cognitive functioning were examined in a sample of developmentally disabled young children.

The emphasis of this study is on establishing the multivariate relationships between biological and environmental variables to the level of functioning of children with developmental disabilities as a group.

Underlying this study are the following major assumptions:

Studies attempting to relate the effects of specific pre-, peri-, or postnatal complications to later cognitive functioning in children using bivariate methods have been generally unsuccessful since they have been able to account for only an insignificant proportion of the variance in cognitive development. However, those studies which have used a multivariate approach and evaluated the effects of combinations of biological problems on cognitive development have been somewhat more

successful in explaining the variance in cognitive development.

Although the data from longitudinal investigations of cognitive development have consistently demonstrated the association or relationship between indices of parental socioeconomic status and children's level of intellectual functioning, much less consideration has been given to the mechanisms by which socioeconomic characteristics translate into environmental process or behavioral variables that may effect the child's cognitive development.

Research efforts which have included both biological and socioeconomic variables have indicated that complex relationships exist between these variables, on the one hand, and level of sensorimotor/cognitive development, on the other, and that these relationships can best be understood using multivariate models.

The following main hypotheses were tested:

1. There is a linear relationship between a combination of biological and environmental variables and sensorimotor/cognitive development.

2. The contributions of the biological variables and the environmental variables are relatively independent of each other in their influence on sensorimotor/cognitive development.

## CHAPTER II

### Method

#### Subjects

All 105 children under the age of 30 months who were diagnosed as developmentally disabled and who were patients of Rhode Island Hospital, Child Development Center Early Intervention Program (CDC-EIP) were eligible for inclusion in this study. The final number of subjects selected was 100. It was necessary to exclude five children who could not be evaluated because their performance was not scoreable due to their multiple handicapping conditions.

The final sample was composed of 63 males and 37 females with an age range of 2 months to 28 months and a mean age of 14 months. Geographically, these children lived in rural, suburban, and urban areas of Rhode Island. The primary languages spoken by their parents or primary caregivers were as follows: 93% English; 4% Spanish; 2% Portuguese; and 1% Cambodian. In terms of the biological parents' marital status: 65% were married; 27% were unmarried; 1% were widowed; and 1% divorced. Six percent of the children were in foster placement at the time of this study and no information was available to their primary caregiver regarding the biological

parents' marital status. The number of siblings of the subjects ranged widely from 0 to 10 with a mean of 1.3 and a median of 1. The number of people living together together in the households of the subjects was also quite variable, scattering from 2 to 12, the average being 4.1 persons per household with the median value of 4. The description of subjects' characteristics given above was based on 100% of parental or primary caregivers' responses to a written self report questionnaire used in the intake process for CDC-EIP.

The following information is based on a subset of the sample described above since some parents or caregivers did not respond to all the items on the questionnaire. The biological mother's educational level was reported in 89 cases, and the average was 11.8 years; the median was 12. The biological father's educational level was reported in 69 cases and the average was 12.8 years with a median of 12. Of the 75 families who responded to the question regarding the payment sources for medical services rendered to their developmentally disabled child, 45% indicated they were presently receiving some form of public assistance, while 55% stated they were covered by a private insurance carrier. Table 1 summarizes the demographic characteristics of the subjects and their families.

Table 1

## Characteristics of Subjects

Characteristic		Subjects
Age in months (N = 100)	<u>M</u>	14.12
	<u>SD</u>	7.45
Sex (N = 100)	Males	63%
	Females	37%
Primary Language (N = 100)	English	93%
	Spanish	4%
	Portuguese	2%
	Cambodian	1%
Biological parents marital status (N = 100)	Married	65%
	Unmarried	27%
	Widowed	1%
	Divorced	1%
	Unknown	6%
Subjects living arrangement (N = 100)	With biological parent(s)	94%
	In foster placement	6%
Siblings (N = 100)	<u>M</u>	1.31
	<u>SD</u>	1.72
People living in household (N = 100)	<u>M</u>	4.13
	<u>SD</u>	1.67
Biological mothers' educational level in years (n = 89)	<u>M</u>	11.83
	<u>SD</u>	3.14
Biological fathers' educational level in years (n = 69)	<u>M</u>	12.81
	<u>SD</u>	3.24
Payment sources for medical services (n = 75)	Public Assistance	45%
	Private Insurance	55%



## Measures

All the information used in this study was collected routinely as part of the CDC-EIP multidisciplinary team's ongoing diagnostic and intervention program for young children with developmental disabilities. It was available to the researcher since she was a member of that multidisciplinary team. The following section contains a description of the measures used and is organized according to their function in the research design: scales used as independent variables are presented first, and then the instrument used as the dependent variable is discussed. Copies of the measures themselves may be found in the Appendix.

Independent Measures. The Rochester Research Obstetric Scale (ROS) was developed by Zax, et al. (1977) to objectively record conditions relating to early biological influences. Twenty-seven items relating to the mother's pregnancy, labor and delivery, and the status of the newborn are included on this checklist. Each item is scored for the presence or absence of specific obstetrical and neonatal states. Scores on this checklist can range from a low of 0 to a high of 41. The lower the score, the fewer difficulties encountered by the mother or infant during the prenatal and perinatal periods. Information necessary to complete

this scale was gathered from the birth records of all the subjects by the researcher. According to the authors Sameroff, Seifer & Zax (1982), items on the ROS were derived from work by Prechtl (1968) and Parmelee (Beckwith, Cohen & Parmelee, 1973) in their efforts to quantify biological risk factors. The items selected from previous research were those which demonstrated that the presence of particular conditions discriminated between normal and abnormal neonates as defined by neonatal morbidity and mortality. "The items were adjusted to United States standards of obstetrical treatment using norms derived from the Collaborative Study of 40,000 pregnancies" (Niswander & Gordon, 1972), according to the authors of the ROS, Sameroff et al. (1977, p. 21). A copy of the ROS may be found in Appendix A.

Research using the ROS has been confined primarily to longitudinal studies attempting to establish the relationships between certain biological risk factors and later outcome variables. For example, in the Sameroff et al. (1982) article reporting the preliminary results of an ongoing project begun in 1970 to study the development of at risk children born to mothers with diagnosed psychopathology, the ROS was used

to document the complications experienced during the prenatal and perinatal periods. Of the many results reported, the one of most relevance in this context, is that when hierarchical multiple regression was used with also possible orderings of the independent variables, maternal social status, severity of illness, and diagnostic category of psychopathology, all were found to be statistically significantly related to the ROS score. However, social status contributed effects beyond those of severity of illness and psychiatric diagnosis, although it only explained 5% of the variance in the childrens' ROS score.

The Pediatric Complications Scale (PdCS) was developed by Littman & Parmelee (1978) to systematically record information regarding each child's hospitalizations; physical development (head, weight, and length growth rates); and presence of congenital, neurologic or sensory abnormalities. The Pediatric Complications Scale (PdCS) consists of a series of items which are checked during a routine pediatric neurodevelopmental examination. The total score simply is the number of items checked. Scores can range from 0 to 22. The higher the score, the greater the number of abnormalities present. This instrument serves as another assessment of the biological influences on a child during

infancy and early childhood. The PdCS is located in Appendix B.

In a study conducted by Littman & Parmelee (1978) with preterm infants, the PdCS at 9 months was found to have a significant correlation with the 9 month Gesell developmental quotient and to the Bayley Mental and Motor Scales at 18 months of age. No other measures of obstetrical or postnatal complications correlated with developmental assessments at either 9, 18, or 24 months of age.

The Home Observation for Measurement of the Environment (HOME) was used to assess the qualitative and quantitative aspects of each child's home environment. This inventory has been revised several times and in its current form consists of six subscales: Emotional and verbal responsiveness of parent; Acceptance of child's behavior; Organization of physical and temporal environment; Provision of appropriate play materials; Parent involvement with child; Opportunities for variety in daily stimulation (Bradley & Caldwell, 1984). However, only the total score of all the subscales combined is used in this study since there is no evidence that the use of the individual subscale scores is justified, either in the manual or from personal communication (R.H. Bradley, personal

communication, November 8, 1984). The authors of the HOME report high levels of inter-observer agreement, "90% or better" (Bradley & Caldwell, 1984, p. 17), based on observations of 174 families. According to the test manual, test-retest reliability coefficients have been calculated among data collected on the same children at 6, 12, and 24 months of age. These coefficients ranged from .62 to .77 for the total score. An internal consistency estimate, based on the Kuder-Richardson 20, was .89 for the total scale. Item analysis, using point biserial correlations, were carried out between each item and the total scale score. These correlations ranged from a low of .05 to a high of .70 with most coefficients in a moderate range. The item with the lowest value, "when mother is away, care is provided by one of three regular substitutes," was one which was best able to discriminate those families most in need of supplemental stimulation in their home and was sensitive in "detecting adverse environmental conditions"(Bradley & Caldwell, 1984, p. 20). The manual also reports extensive concurrent validation studies which have been conducted using the HOME. Correlations between SES variables (mother's education, father's presence, father's education, father's occupation and crowding in the home) were all significantly correlated with the total score on the HOME administered when a group of children were 24 months of

age. In order to assess the relationship between the HOME and tests of mental development, both measures were administered when the child was 6, 12, 24, and 36 months of age. Ninety-one children and their families were included in these studies. The correlation between the 6-month HOME total score and the 36-month Stanford-Binet I.Q. was .50. The total HOME score of 24-months was correlated .71 with I.Q. at 3 years. Using data from the same children and families in a follow-up study, the correlation between HOME total scores at 6 months and Stanford-Binet I.Q. at 54 months was found to be .44, while the correlation between HOME total scores obtained at 24 months and I.Q. at 54 months was .57. In a further analysis of these data, the HOME was a better predictor of Stanford-Binet at age 3 than the combination of the SES variables, referred to earlier (Bradley & Caldwell, 1984). Total scores on this inventory can range from 0 to 45. The highest score indicates that the inanimate and animate aspects of the child's home environment are providing what the authors refer to as "a quality life for children" (Bradley & Caldwell, 1984, p. 98). The HOME can be found in Appendix C.

Dependent Measure. The Bayley Mental Scale of Infant Development (BMSID) was individually administered to determine the subjects' developmental status in terms of present level of sensorimotor/cognitive functioning.

According to the Manual:

The Mental Scale is designed to assess sensory-perceptual acuities, discriminations and the ability to respond to these; the early acquisition of "object constancy" and memory, learning, and problem-solving ability; vocalizations and the beginnings of verbal communication; and early evidence of the ability to form generalizations and classifications, which is the basis of abstract thinking. Results of the administration of the Mental Scale are expressed as a normalized standard score, the MDI or Mental Development Index. (Bayley, 1969, p. 3)

The Mental Development Index (MDI) has a mean of 100 and a standard deviation of 16. Items on the scale are arranged in sequence according to the chronological ages at which 50% of the children in the standardization sample passed that item. The present scale was standardized between 1958 and 1968 on a sample of 1,262 children stratified by sex, color ("white" and "nonwhite"), rural-urban residence, and education of the head of household. Split-half reliability coefficients range from .81 to .93, as stepped-up by the Spearman-Brown formula. Standard errors of measurement range from 4.2 to 6.9 MDI units. The inter-rater reliability information available is based on the preliminary version

of the scale and is reported at 89% agreement, based on 90 observations. Test-retest reliability after a one week interval is reported to be 76.4 percentage agreement. Concurrent validity with the Stanford-Binet was established for a group of 120 children who were 24-, 27-, and 30-months old. The coefficient of correlation for the total group was .57, indicating that somewhat different aspects of cognitive development are being measured by these two instruments. The Bayley Mental Scale is appropriate for use with children 1 month through 30 months of age (Bayley, 1969).

#### Procedure

The data used in this study were generated as a result of a child's referral to and participation in CDC-EIP which was one of two statewide diagnostic and intervention programs for developmentally disabled children under the age of 3 years until it closed on December 31, 1985. Referrals to the CDC-EIP came primarily from pediatricians or visiting nurses in the community and hospital-based personnel who treated the child as an inpatient. Referral to the program was made only after parental consent had been obtained by the referring agent and parents were able to withdraw from services at any time. As part of the referral process, parents signed consent forms releasing pertinent medical



records (e.g., obstetric records, pediatric records, etc.) to the CDC-EIP and filled out a questionnaire requesting background information about the child and family.

Once all the relevant background and historical information was obtained on a child who had been referred, parents were contacted in order to schedule a multidisciplinary evaluation of their child. The professionals involved in conducting this evaluation varied depending on the needs and age of the child, as well as the family. As a minimum, however, the following professions were represented: audiology; physical therapy; psychology; pediatric medicine; and social work. Additional specialists, e.g., occupational therapists, neurologists, etc. were available, on an as needed basis. The goals of the evaluation process for those who were referred to CDC-EIP were twofold: to document eligibility for ongoing services on the basis of a developmental disability, i.e., cerebral palsy, blindness/visual impairment, deafness/hearing impairment, meningomyelocele, hydrocephalus, seizure disorder, autism, developmental delay, mental retardation; and to ascertain baseline levels of functioning in order that an individualized program plan could be written for each child and family. These formal individualized program

plans were generated annually for each child and family. They included: summary statements of the child's relevant medical history and current medical status; descriptions of present levels of functioning in all areas of development; goal and objectives of the habilitative program; and an outline enumerating the personnel and schedule of activities planned for the child and family for the forthcoming year. After these plans were drafted, parents indicated their consent to continued participation by signing the individualized program plan. A sample plan is shown in Appendix D. In addition, regularly scheduled appointments with the child and parents in their home, at approximately 6 to 8 week intervals, insured continuous updating and monitoring of the individualized program plan.

The results of each individual discipline's evaluation, as well as the composite multidisciplinary team summary, obstetrical records, and individualized program plans were maintained in each child's record.

Confidentiality of information gathered by the CDC-EIP was guaranteed by limiting access to the records to only those CDC-EIP personnel who were directly involved with the child and family. Release of any information to agencies or professionals outside of the

Child Development Center occurred only upon parental request and signed parental consent.

Confidentiality of the information used in this study is maintained by the principal investigator who was responsible for abstracting the information from each subject's record, and coding the data so that it is not personally identifiable.

All records relating to this project were handled and safeguarded according to standard hospital policy for all medical records. Medical records were always dealt with in conformity with the Rhode Island Act relating to the confidentiality of health care information.

In order to complete the ROS for each subject, the principal investigator reviewed the information contained in each child's record regarding the mother's pregnancy, delivery, and the subject's condition at birth. Each item on the ROS was credited if it appeared in the obstetrical history. Due to the fact that many of the subjects in this study were born to mothers considered to be "high risk" during their pregnancy and/or because many of the subjects experienced difficult births (e.g., trauma), the majority of records reviewed were from Women & Infants Hospital which uses a standardized format for recording the events surrounding birth.

The PdCS was completed on each subject, based on the results of a pediatric neurodevelopmental examination

which was a standard component of the multidisciplinary team evaluation of each child referred to CDC-EIP. Although every attempt was made to conduct the pediatric neurodevelopmental examination as close in time as possible to the administration of the criterion measure, BMSID, it was not always possible to do so due to problems in scheduling. For example, youngsters may have been ill or hospitalized and were not able to be examined at the scheduled appointment time for one examination or the other. On the average, there was a 3.5 month interval between the neurodevelopmental examination and the administration of the BMSID. Each item was scored on the PdCS if an abnormality existed at the time of the examination by the pediatrician or if there had been treatment for a particular medical condition prior to the examination.

The HOME Inventory was completed by one of CDC-EIP team members during regularly scheduled visits to the home of the subjects. Observation and interview techniques were used in accordance with the instructions in the manual in order to obtain the relevant information from the primary caregiver of the subject. Inter-rater reliabilities were established at an average of .89 between all possible pairs of team members prior to the gathering of the data used in this study as well as at

several points during the data collection process. Scoring of the items was in strict accordance with the guidelines specified in the manual.

It was usually necessary to make two home visits within a 2 month period in order to collect all the information necessary for completion of the HOME, since merely collecting the data was not the primary intent of the home visit. The focus of the visit in the home was to monitor and update the goals and objectives of the individualized program plan which had been designed for each child and their family.

As with the PdCS, an attempt was made to administer the HOME as close in time to the criterion measure, BMSID, as was possible, but the average length of time between the two measures was approximately 2 months.

The BMSID was administered to all children referred to CDC-EIP who were between the ages of 1 and 30 months as part of the CDC-EIP multidisciplinary evaluation. This assessment was conducted and the items were scored in accordance with the directions given in the manual and the Supplement to the Manual for the Bayley Scales of Infant Development (Rhodes & Bayley, 1983). The BMSID was given to each child by two qualified examiners between whom inter-rater reliabilities had been established at .91 prior to compiling the data to be used

in this study. During the data gathering, several reliability checks occurred between the examiners each indicating that the initial high levels of reliability were being maintained. Approximately 85% of the testing was done by the principal investigator. As was mentioned earlier, the BMSID was administered on the average of 3.5 months from the time of the child's neurodevelopmental examination and within an average of 2 months time from the completion of the HOME Inventory.

## CHAPTER III

### Results

The major method of data analysis employed in this study was multiple regression analysis. Scores from all 100 subjects on the ROS, PdCS, and HOME were used as independent variables and the MDI used as the dependent variable. Data were analyzed using the SPSS-X subprogram Regression (Nie, Hull, Jenkins, Steinbrenner, and Bent, 1983). These computer analyses were executed on the main frame (IBM 4381-3) at the University of Rhode Island.

Multiple regression techniques were applied for the purpose of examining the relationships between the linear combinations of independent variables and the dependent variable. In all, 6 separate analyses were initially performed in order that the most satisfactory subset of the independent variables could be found to maximally account for the variance in the dependent variable, and to determine the relative contribution of each independent variable to the dependent variable without redundancy. Subsequently it was discovered that due to the nonsignificance of one of the independent variables and the mutual lack of any significant correlation between the remaining two, reporting the results of one analysis is deemed sufficient.

However, prior to the carrying out of the multiple regression analyses preliminary analyses were performed in order to assess the characteristics of and the individual relationships between the variables drawn from the sample investigated in this research.

Univariate Distributions. The distribution of each variable to be entered into the multiple regression equations was plotted using the Biomedical Computer Program (BMCP) 5D program (Dixon, 1976) in order to evaluate the basic distributional characteristics of the individual variables before subjecting them to subsequent analyses. The 4 moments of these distributions were calculated using SPSS-X subprogram "Condescriptive" and are shown in Table 2. As can be seen from this Table, all the distributions with the exception of the HOME are slightly positively skewed indicating that the cases are clustered more to the left of the mean and that the majority of the extreme values are to the right of the mean. On the other hand, the plotted values of the HOME indicate a slight negative skewness to that distribution suggesting that the cases are clustered more to the right of the mean with most extreme values being to the left of the mean. It is felt that although these distributions depart somewhat from normality the discrepancies are not significant enough to violate the



assumption of symmetry.

Table 2

Moments of Distributions of Measures

Measure	<u>M</u>	Variance ( <u>SD</u> )	Skewness	Kurtosis
HOME	33.360	36.435 (6.036)	-.260	-.615
ROS	6.050	9.018 (3.003)	.138	-.662
PdCS	5.190	6.155 (2.481)	.312	-.677
MDI	61.040	537.453 (23.183)	.557	.137

Inspection of the values for kurtosis from Table 2 reveals that the distributions of all the variables, with the exception of MDI are slightly negative. This platykurtic feature indicates that the values plotted tended toward the extremes of the distribution. The kurtosis of MDI is slightly positive and, therefore, somewhat leptokurtic in shape with most cases grouped in the center of the distribution. Although there is some digression of the distributions of these variables from the mesokurtic shape of the normal distribution, the tolerance of the Pearson  $r$  for digressions from normality is substantial when continuous measures have been

gathered on a sufficiently large number of independent observations.

The mean of each variable was determined as a description of the central tendency of the distribution. These values are also reported in Table 2.

Variances were computed for all the variables to be used in the succeeding data analyses as measures of the dispersion of the data from their respective means. These variances are relatively widely ranged indicating heterogeneity in the data and little restriction in range. The minimum and maximum scores for each of the variables are: HOME, 19 and 44; ROS, 0 and 13; PdCS, 0 and 11; MDI, 28 and 139.

Bivariate Distributions. The zero-order correlations between all possible pairs of variables used in the data analyses was calculated as part of the SPSSX program 'Regression'. Those correlations are shown in Table 3. Inspection of this table reveals the following in terms of the independent variables: These variables were found to have virtually no overlap with each other. Pearson product-moment correlation coefficients ranged from  $-.024$  to  $.096$ . None was statistically significant ( $p > .05$ ) and the variance accounted for by the overlap between the measures was less than 1% in each case. However, in terms of the Pearson product-moment correlations between each of the

independent variables with the dependent variable, the following is noted from the Table: Both the HOME and the PdCS show moderate correlations with MDI (.35 and  $-.41$ , respectively) and both relationships are statistically significant ( $p < .001$ ). The overlap of the HOME with MDI accounts for 12% of the variance while the overlap of the PdCS with MDI accounts for 17% of the variance. The amount of variance in MDI explained by the ROS is negligible, since it represents only .1%.

Table 3

Intercorrelations Between Measures for All Subjects

Measures	HOME	ROS	PdCS	MDI
HOME	----	.059	-.024	.350*
ROS		----	.096	-.042
PdCS			----	-.408*
MDI				----

N = 100

\* $p < .001$

The amount of error which would exist if one were to attempt to predict MDI on the basis of any of the independent variables, using the regression line, is expressed in the residual mean square column of Table 4. This represents the amount of variance which cannot be

explained if the regression line were to be used in prediction.

Table 4

Regression Equations Based on Bivariate Plots

Measures	<u>Equation Components</u>		Residual Mean Square
	Constant	Slope	
MDI vs. HOME	27.796	.09114X	32.296
MDI vs. ROS	6.3852	-.00549X	9.0932
MDI vs. PdCS	7.8596	-.04369X	5.1817

Multiple Regression Analysis. The SPSSX subprogram Regression (Nie, et al., 1985) was used to perform a multiple regression analysis to test the hypothesis that there is a relationship between a linear combination of the independent variables, ROS, PdCS, and HOME, and the dependent variable, MDI. Since the result of multiple regression equation and the total amount of variance explained does not depend on the order in which the variables are entered and since the independent variables were found to be, for all practical purposes, uncorrelated, the following results are reported from the stepwise regression analysis.

Solution of the multiple regression equation resulted in a multiple correlation coefficient,  $R = .53$ , indicating that there is a moderate relationship between the aggregate of the independent variables and the dependent variable. The square of the multiple correlation coefficient,  $R^2 = .2831$ , indicates that 28% of the variance in MDI can be accounted for by a composite of ROS, PdCS, and HOME scores operating together. The  $F$  test was used to test the null hypothesis that the multiple correlation coefficient is, in fact, zero in the population from which the sample used in this study was drawn. The result,  $F_{(3, 96)} = 12.63, p < .001$ , indicates that the null hypothesis can be rejected and that it is highly improbable that this sample was drawn from a population in which  $R = 0$  (see Table 5).

Table 5

Breakdown of Total Sum of Squares

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Regression	15060.52465	3	5020.19488	12.63*
Residual	38147.31535	96	397.36787	

\* $p < .001$

In addition, it can be inferred from this overall test that at least one, if not more than one, of the regression coefficients generated in the multiple regression equation is greater than zero. To test which of the unstandardized regression coefficients is different from zero, a  $t$  test was performed. These results are shown in Table 6. Significant  $t$  tests were found for two of the independent variables: PdCS,  $t_{(96)} = -4.578$ ,  $p < .001$  and HOME,  $t_{(96)} = 3.947$ ,  $p < .001$ . The regression coefficient for ROS was not found to be significant,  $t_{(96)} = -.277$ ,  $p > .05$ . Based on this information, the null hypothesis can be rejected for the regression coefficients of the PdCS and the HOME, but not for the ROS. The 95% confidence intervals for the unstandardized regression weights are also shown in Table 6. As can be seen from this Table, the confidence interval for the regression weight for ROS includes zero as would be expected since the test of its significance was not significantly different from zero. In view of this and the fact that the initial bivariate correlation between ROS and the criterion, MDI, was negligible a decision was made to drop ROS from the multiple regression equation.

Table 6

Stepwise Multiple Regression Analysis

Measure	B	<u>95% Confidence Interval</u>		t
		Lower Limit	Upper Limit	
PdCS	-3.71597	-5.327069	-2.104846	-4.578*
HOME	1.312982	.652712	1.973251	3.947*
ROS	-.186286	-1.519282	1.146710	-.277

N = 100; df = 96

\*p < .001

The final multiple regression equation in raw score form is:

$$\hat{Y} = 36.827755 + -3.738009X_1 + 1.307329X_2$$

where  $\hat{Y}$  = MDI predicted score,  $X_1$  = PdCS score, and

$X_2$  = HOME score.

With the deletion of ROS from the multiple regression equation,  $R^2$  remains at 28% and the standard error of estimate drops slightly from 19.93, when all three independent variables were entered, to 19.84. Therefore, on the average, if one were to attempt to predict MDI scores from a weighted combination of scores on the PdCS and the HOME, MDI scores would vary from

actual scores by 19.93 units on the MDI measure.

The 95% confidence interval for estimating the population mean MDI score from the sample has the limits ranging from 57.15 to 64.93.

A check was made on the accuracy of the multiple regression equation for predicting an MDI score for a given individual whose scores on the independent variables are known, for example, 5 on the PCS and 33 on the HOME, and the 95% confidence interval was calculated as follows:

$$\begin{aligned} \hat{Y} &= 36.827755 + -3.738009(5) + 1.307329(33) \\ \hat{Y} &= 61.279567 \end{aligned}$$

The 95% confidence interval for this score would range from 22.40 to 100.16. Consequently there is a 95% chance that a child's level of sensorimotor/cognitive functioning based on the hypothesized scores specified above will be between the severely retarded and the normal range.

### Partial Correlations

To evaluate the relationships among the variables used in the multiple regression analyses while removing the redundancy, partial correlations were calculated and are shown in Table 7. These correlations can be



interpreted as the relationship between the criterion and an independent variable with the influence of the other independent variable taken out of both the criterion and the independent variable.

If the effects of PdCS are partialled out of both HOME and MDI scores, the remaining partial correlation between MDI scores and HOME scores is .37, which is just slightly greater than the bivariate correlation between the HOME and MDI. A test of the null hypothesis that the population partial coefficient is zero was done. The  $t_{(97)} = 3.96$  permitted rejection of this hypothesis  $p < .001$ .

If the overlap of HOME scores with PdCS and MDI scores is statistically controlled for, the resulting partial correlation between PdCS and MDI is -.43 indicating, again, a slight increase in the strength of the relationship over that which was suggested by the bivariate correlation between PdCS and MDI. To test the null hypothesis, a  $t$  test was calculated. The value  $t_{(97)} = -4.65$   $p < .001$  permits rejection of this hypothesis and implies that the population partial coefficient is not zero.

Partial Correlations using ROS scores were not used since its contribution to the overall analysis was so minimal.

Table 7

Partial Correlations

Measures	r	t
MDI, HOME . PdCS	.37	3.96*
MDI, PdCS . HOME	-.43	-4.65*

$N = 100$ ;  $df = 97$

\* $p < .001$

Semipartial Correlations

To measure the contribution of each independent variable to the dependent variable, semipartial correlations were computed. These are presented in Table 8. For example, to determine the increase in the proportion of variance in MDI accounted for by PdCS that is beyond the proportion accounted for by the HOME, the semipartial  $r_{1(2.3)}$  was computed and squared. The result indicates that PdCS is accounting for 16% of the variance in MDI over that explained by the HOME. On the other hand, examining the increase in explained variance of the MDI accounted for by the HOME beyond that explained by PdCS, by squaring the semipartial correlation  $r_{1(3.2)}$ , shows a 12% increment in the variance.

Since the contribution of ROS was shown to be non-significant in previous analyses, it was not included in the calculations of the semipartial correlations.

Table 8

Semipartial Correlations

Measures	r	$r^2$
MDI (PdCS•HOME)	-.399920	.1599
MDI (HOME•PdCS)	.340287	.1157

Relative Contributions of Independent Variables

Since the independent variables were relatively uncorrelated, the percentage contribution of each of them to the variance in MDI was determined by simply dividing the square of the bivariate correlation by the total variance explained by  $R^2$ . The results are: 57.19%, PdCS; 42.29%, HOME; and .52%, ROS.

## CHAPTER IV

### Discussion

This study was conducted for the purpose of gaining a more comprehensive understanding of the complex relationships among pre-, peri-, and postnatal complications; physical development; characteristics of the home environment; and level of sensorimotor/cognitive functioning in young children who are developmentally disabled. It is with this goal in mind that the results are discussed.

#### What is the Relationship Between Biological and Environmental Influences to Cognitive Development?

The results of this study indicate that there is a significant, although moderate, relationship between a combination of biological and environmental influences, on the one hand, and level of sensorimotor/cognitive development, on the other, in young children with developmental disabilities. This relationship explains about 28% of the variance.

It was discovered from the data analysis that a subset of the aggregate of biological and environmental variables used as independent measures in the data analysis could be selected which was as effective in

accounting for level of sensorimotor/cognitive development as the entire original set of variables. Specifically, it was possible to eliminate the ROS without effecting the overall accuracy of the regression equation.

Efforts to generalize the regression equation derived from the data used in this study are not warranted at this time due to the biased nature of the sample from which the data were generated. As will be recalled, the sample consisted of a group of already identified young children with developmental disabilities who had been referred to the CDC-EIP program. They were not randomly selected for participation in this investigation. It was not within the purview of this experimenter to have access to a larger population from which a stratified random sample could have been drawn in order to serve as a basis for conclusions regarding the external validity of the regression system.

Also, extreme caution must be exercised in any attempt to operationalize this regression system since only 28% of the variance in level of cognitive development is explained by the combination of biological and environmental influences studied in this investigation. As was demonstrated in the previous section, at the 95% confidence interval an individual child's MDI could range from the severe to the normal

levels of cognitive functioning. In order to contemplate the operationalization of such a system it would be necessary to find additional variables that could at least double the amount of variance accounted for by this system. This unexplained variance may have been due to the failure of the ROS and/or PdCS to adequately measure biological factors as well as the weakness of the HOME in measuring potentially relevant environmental aspects.

Additionally, it would seem that efforts aimed at cross-validation of this system in its present form would be wasted time since further exploratory studies need to occur, as mentioned above, before confirmatory studies are made. Subsequent investigations are needed to define additional independent measures which, while having little redundancy with the measures used in this study or with each other, do have significant relationships to the level of sensorimotor/cognitive development in young children with developmental disabilities. Once this optimal combination of variables is found, replication and cross-validation studies are critical in order to establish the stability of the weights assigned to each of the measures prior to the application of the regression system.

Although no study could be found in the literature which assessed these combinations of variables

concurrently and with a group of already identified handicapped children, there are some comparisons with other studies needing to be mentioned.

With an unselected sample, Werner et al. (1967) demonstrated that by age 2, the relationship between perinatal complications, the quality of the home environment and development was established such that increased perinatal complications combined with impoverished environments served to significantly increase the number of 2 year olds considered to be abnormal. These results have been consistently replicated in studies with other samples reported previously (Smith, et al., 1972; Escalona, 1982; Willerman, et al., 1970; Broman, et al., 1975; Zax, et al., 1977; Siegel, 1981; Mitchell, et al., 1985).

The results of this present investigation are also in agreement with some recently published works which address these relationships in biologically at risk samples. The at risk population which appears to have commanded the most attention, in this regard, has been the preterm infant. Currently, this is the group to whom advancing technologies are most often directed, in the continuing effort to reduce infant morbidity and mortality. The question most often posed in these studies is to what degree the home environment can mitigate biological risks.

As part of a longitudinal project, Beckwith & Cohen (1984) have reported on the relative effects of social factors on cognitive development in groups of preterm infants who did not exhibit any congenital anomalies or syndromes. Using correlational techniques and two relatively small samples, one English-speaking and one Spanish-speaking, the authors conclude that "social factors were found to be as important to cognitive test performance of high-risk infants as previous research has indicated for normal, term infants." (p. 262)

Findings leading to this conclusion were as follows: across the 5 year period of the study, developmental and IQ test scores were related to social factors, not perinatal complications; that although SES was not found to be related to infant test performance, it was modestly related to test scores by age 2 and by age 5 there was a strong relationship; when SES was partialled out, children which received the most responsive caregiver interactions consistently performed more competently on earlier developmental and later IQ tests.

Siegel (1985) compared two cohorts of preterm and full term infants matched on SES, gender, parity and maternal age in order to assess the differences in environments between the groups and to determine the relationship between the environment and cognitive performance. Using relatively small samples and t



techniques to test for environmental differences, the author concludes that over a five year period "there do not appear to have been significant environmental differences between the preterm and full term births". (p. 208) In terms of the concurrent relationships between measures of the home environment and developmental level, at 12 months of age there were no significant relationships found for either the full term or pre term group. However, by 5 years of age, significant correlations were found between an overall assessment of the home environment done at age 3 and intellectual functioning in youngsters who were born full term. Only a specific aspect of the environment, physical punishment, was related to intellectual functioning of children born pre-term.

An interesting result of Siegel's data analysis was that when the relationship between the home environments of children who showed developmental delay early but functioned normally at 3 years of age was examined, it was found that their environments were more stimulating. The converse of this was also found, that children who were developing normally early but were delayed at 3 years came from less enriched environments. Siegel (1985) has concluded from her 10 year study of preterm and full term infants that "It may be that the biological factors are more significant determinants

of early scores but the influence of the environment appears to be greater for functions that mature later, especially language". (p. 71)

From their comprehensive review of studies dealing with the effects of the environment on early cognitive development, MacPhee et al. (1984) have suggested that "these data . . . support McCall's [1981] 'scoop model' of cognitive development, whereby intelligence is relatively canalized until about 2 years of age. After 2 years, though, maturational factors ebb and genetic variability and environmental factors are, perhaps, more influential". (p. 354)

#### Are the Contributions of the Biological and Environmental Influences Independent of Each Other?

It was found that each of the independent variables studied were relatively independent of each other in their concurrent influences on sensorimotor/cognitive development.

The contribution of the pre-, peri- and postnatal factors as measured by the ROS was found to be negligible in this sample, accounting for less than 1% of the variance in sensorimotor/cognitive functioning. This instrument is an example of those typically used to document biological risk factors occurring during the pre-, peri- and immediate postnatal period. In this

study, with an already identified group of children with disabilities, it was not found to be useful, either statistically or practically. However, requesting and reviewing obstetrical records has been accepted as routine procedure by many health, mental health, social service and educational practitioners dealing with this population. It would appear that somehow professionals are still operating under the presumptions of the medical model in as much as thinking that somehow knowing this information will contribute to their understanding or treatment of the handicapped child and family. Littman and Parmelee (1978) demonstrated that although significant relationships existed between quantitative scores of combinations of medical events and cognitive development at 18 months of age in pre-term, low-birth infants, only 5% of the variance was actually explained.

Based on this study, the relevance of gathering information gleaned from birth records, a time consuming activity, to the explanation of handicapped children's cognitive development is called to question.

In comparing the number of medical complications reported in pregnancy or at birth on the ROS for this sample with other samples drawn from healthy populations, e.g., Barnard, Bee and Hammond (1984), there is a three fold increase.

Inspection of the ROS data indicates that the majority of mothers of subjects in this study had no prenatal complications. However, of those who did, the most frequent finding was a chronic disease or infection, followed by the use of chronic medications. During delivery, almost three-fourths of the mothers experienced some problems, with the foremost problem being the use of an anesthesia greater than a local or pudental block. The next most frequent occurrence was delivery was by a Cesearean section. In terms of the infant's status at birth, 92% had one or more risk factors, with the vast majority having more than one. The presence of physical disorders was the most frequent occurrence followed by the need for resuscitation. This is consistent with the composition of the sample, a group with established risk for developmental disabilities.

The contribution of the PdCS to concurrent level of sensorimotor/cognitive development, MDI, in this sample was the most substantial of the variables studied, accounting for approximately 58% of the explained variance; and indicates that many youngsters experienced medical complications after the neonatal period, which are not directly related to perinatal factors. On the average, between 2 and 28 months of age, the children had experienced 5 pediatric complications. As may be expected, the most frequently reported illness was upper

respiratory infections often followed by otitis media. Over half of the children had been hospitalized for illnesses, while less than half had been hospitalized for surgery. Problems in growth varied; 9% had problems in their rate of length growth, while 24% had abnormal head growth and 20% had abnormal weight gain. In regard to the latter, slightly over a quarter of the children in the study had feeding difficulties. Thirty percent of the sample had at least 1 seizure. The most frequently occurring congenital anomaly was an abnormal heart murmur. Neurological abnormalities were relatively common with the most often identified difficulty in the neuromusculature of the extremities. Sensory deficits were found at an alarming rate with 15% having a hearing deficit and 37% with a visual deficit.

The negative regression coefficient associated with the PdCS in the regression equation suggests that it is inversely related to MDI; as the number of pediatric complications increases, MDI decreases.

The contribution of the HOME to concurrent level of sensorimotor/cognitive development, MDI, in this sample, accounted for 42% of the explained variance. With regard to other studies which have used the HOME, several comparisons are noteworthy. The mean HOME score of this sample is consistent with other samples which were composed of middle to lower socioeconomic class healthy

youngsters (Bradley & Caldwell, 1984). This suggests that, at least early in development, the home environment may not be significantly different for handicapped versus non-handicapped youngsters. This should be tested in future studies. The mean HOME score of this sample was also found to be comparable to the mean of a group of 12 month old children whose mothers had a high school education or less (Barnard, et al., 1984). The relationship between the HOME and MDI as determined in the present investigation was relatively stronger than has been reported for similar, but normal, age groups (Elardo, Bradley & Caldwell, 1975; Bernard, et al., 1984). This, too, should be addressed in future studies and may indicate that the impact of the environment on the development of the handicapped occurs earlier and more potently than originally thought.

The positive regression coefficient associated with HOME scores suggests that there is a positive relationship between those scores and MDI, indicating as HOME scores increased MDI scores also did.

The sample upon which this study was based was an already identified group of developmentally disabled children who differ significantly from other populations. For example, a comparison of this sample's mean MDI score with the norms of the Bayley Mental Scale clearly indicates that this sample is functioning, on the

average, greater than 2 standard deviations below the mean. The large size of the standard deviation for this sample on this measure indicates that there is a great deal of variability in levels of functioning.

Examination of the primary diagnosis of the sample studied indicates the following: 30% had conditions known to be associated with mental retardation, i.e., the syndromes of Down, Dandy-Walker, Turner, cri-du-chat; Gangliosidosis; Cytomegalovirus; 12% seizure disorders; 12% cerebral palsy; 10% hydrocephalus; 6% myelomeningocele (meningomyelocele); and, 4% severe visual impairment or cortical blindness. However, 26% of the children presented with global developmental delay of unknown etiologies. In this category it may be that subtle medical conditions have interacted with environmental influences to create those children known in the literature as having "double vulnerability" (Magyary, personal communication, 1986). Certainly more extensive study is indicated.

The consequences of this study are clear. Both an assessment of neurodevelopmental status, through a thorough pediatric examination as recorded on the PdCS; and an assessment of the environment, as measured by the HOME, independently contribute to sensorimotor/cognitive development in young children with developmental disabilities. The fact that the ROS, which served to

document pre-, peri-, and immediate postnatal complications contributed so little to the regression system invites speculation. It may be that there was either too little variability in this sample or that the effects of obstetrical problems on development may simply be transient. By an average age of 14 months, the effects of obstetrical problems may have been supplanted by pediatric complications and the influences of the environment.

Further points need to be made. The nature of the pediatric examination used as part of the data base for this study is quite different from the typical pediatric examination. Most often a routine pediatric examination is conducted in a hurriedly manner with little attention paid to previous illnesses and hospitalizations; systematic recording of growth parameters; neuromuscular status; or tests for sensory deficits. In addition, assumptions have often been made that somehow because a child has a diagnosed handicapping condition there is no need for thorough examination or treatment anyway. For example, a child with Down syndrome who has chronic upper respiratory infections resulting in otitis media may not be treated with myringotomies and ventilation tubes to prevent or treat a hearing loss, whereas another child would. The child with Down syndrome is presumed to be slow to learn to talk anyway.



In a similar vein, few attempts have been made to routinely conduct thorough objective assessments of the home environments of handicapped children and examine its relationship to development. Although most would probably not dispute the environmental influences on the development of healthy youngsters, this issue is often virtually ignored when dealing with the handicapped population. Most all diagnostic evaluations and follow up occur in clinics or hospital settings with no regard for the milieu in which the handicapped infant is reared.

## CHAPTER V

### Implications

To some extent, the issues addressed in this study are a resurrection of the nature-nuture controversy. Promulgated by such infamous works as the Skeels and Dye study (1939, 1966) and J. McHunt's Intelligence and Experience (1961), it has been generally agreed that the biologically normal infant is shaped by environmental factors. Much less agreement historically has existed regarding the influences of the environment on a biologically abnormal infant. For example, it is noteworthy that it required federal legislation in 1975 to insure that the handicapped have a right to free and appropriate education. Early Intervention programs, serving the birth to three handicapped population, are not federally mandated.

As a result of ever-increasing breakthroughs in the fields of obstetrics and neonatology it may be assumed that there will be an increase in the incidence of the biologically vulnerable infant. Yet the controversy rages over whether or not these infants are subject to the same environmental effects as are normal infants and/or whether the presence of an abnormal infant impacts on the

environment in such a way as to change it from what it would have been in the case of a normal infant. Findings from this study suggests that it does not.

For the most part, the simplistic notion of whether it is heredity or environment which is the most important factor in determining psychological characteristics, e.g., level of intellectual functioning, has been abandoned for the normal population. But for the infant who has suffered biological trauma, this age old controversy has taken a new twist. Heredity has been replaced by obstetric and neonatal risk factors.

The medical literature is replete with correlational studies attempting to relate specific medical conditions in neonates to outcome with few concerns for environmental influences on development. This has severe consequences since it is the pediatrician who, most often, assumes the role of informing parents of their child's handicap and advises them about expected outcomes. The literature would suggest that this is being done independently of knowledge regarding the physical and social environment of the family.

If the true nature of the influences on sensorimotor/cognitive development in children is to be understood, then strong relationships between those influences and cognitive functioning need to be discovered. The influences which were hypothesized and

tested in this study showed only a moderate relationship to concurrent level of cognitive development indicating there is a pressing need for continuing research in this area to identify additional variables.

Some recent investigations may be useful in lending direction to future studies, especially in regard to understanding the development of the handicapped. They are those which have examined qualitative aspects of the environment other than those in this study. For example, Bristol's study (1984) of families of autistic children suggests that there is "a developmental progression of stresses in families of autistic children" (p. 110) which can be expected to interact with the child and effect development differentially at various points in time. She concludes that "family adaptation to the child . . . was more closely related to perceived adequacy of informal social support than to severity of the child's handicap". (p. 125) The relationship between social supports and stresses is known with the use of informal social supports often being viewed as effective coping mechanisms against stress (Unger & Powell, 1980). What is not known are the relationships among the families' social support system and stress to handicapped children's development. In a survey article (Gallagher, Beckman, & Cross, 1983), evidence is given indicating

that parents of handicapped children experience stress to a greater degree than parents of non-handicapped children. Studies have reported that parents of handicapped children have increased divorce and suicide rates; greater risk for child abuse; additional financial difficulties; decreased social mobility; and feelings of depression, guilt, anxiety, anger and isolation. Consequently, it would seem that there is a research need for studies which incorporate both measures of familial stress and support systems.

In addition, a review of the literature by MacPhee, et al. (1984) regarding experiences that influence cognitive development, in the normal population, suggest that those which are the most powerful are a cluster of parental characteristics which the authors' label "encouragement of development". (p. 348) These authors indicate that the following variables consistently have been shown to be related to children's competence

Achievement-motivation (McApplebaum, & Hogarty, 1979); engaging in intellectually stimulating activities (Beckwith & Cohen, this volume; Carew, 1980; Clarke-Stewart, 1973); and providing a variety of stimulating experiences for the child, including responsive play materials and field trips (Bradley & Caldwell, Chapter

2, this volume; Elardo, Bradley & Caldwell, 1977; Gottfried & Gottfried, Chapter 3; Johnson et al., Chapter 5, this volume; Wachs, 1978; 1979). (p. 348)

How these variables effect the development of competence in handicapped children remains unknown.

After Sameroff and Chandler's (1975) extensive review of longitudinal studies attempting to relate biological risk factors to developmental consequences and, hence, to test Pasamanick and Knoblich's continuum of reproductive causality they concluded that most infants who are exposed to pre- and perinatal complications have normal outcomes. In their efforts to explain this phenomena, they have hypothesized a "continuum of caretaking causality". (p. 236)

Sameroff (1985) has suggested that there are cases where the abnormal biological influences on a child's development may be so extreme that it is beyond the capability of the mechanisms of the social environment to mitigate these influences but, on the other hand, there may be social environments which are so abnormal that they create casualties from biologically normal infants. In an effort to sort out the interactions of risk factors in a "continuum of caretaking causality", a comprehensive multivariate study was undertaken known as the Rochester Longitudinal Study (Zax et al., 1977).

Eleven variables assumed to be related to cognitive or social-emotional competence were selected for study: "severity of maternal illness, chronicity of maternal mental illness, maternal anxiety, parental perspectives, maternal interactive behaviors, maternal education, occupation of head of household, minority group status, family social support, stressful life events and family size." (Sameroff, 1985, p. 28) On the basis of these variables a low risk and high risk group were formed. At 4 years of age, the two groups of children differed significantly on the two outcome measures, Wechsler Primary and Preschool Verbal Intelligence Scale (WPPSI-VIQ) and the Rochester Adaptive Behavior Inventory (RABI). A further analysis of the data indicated that as the number of multiple risk factors increased, there was a linear decrease in WPPSI-VIQ. On the RABI, there was almost a three times difference found between the two groups. In summarizing their data they concluded:

the probability of very poor outcome is 30 times greater for cognitive competence and 7 times greater for social-emotional competence as one moves from low-risk to high-risk status. Conversely, the probability of superior outcomes are 25 times less likely for cognitive competence

and 13 times less for social-emotional competence in the high-risk group.

(p. 34 & 35)

As a consequence of these results, these researchers turned toward increasing parents' abilities to understand the development of their child. The assumption is that a parent's understanding of their child's development is a reflection of their own level of thinking. Using SES as a blocking variable, it was found that generally lower SES groups did not operate at the "perspectivistic level" (p. 37) which permits hypothetical thinking and the understanding that transactions occur with parents effecting the child's behavior and vice-versa.

Unfortunately no study was located which directly assessed the effects of the caregivers level of conceptual thinking on their children's level of cognitive development. Yet as Haines (1985) points out the emphasis of most early intervention programs for handicapped or at risk infants is on parent education. In a review of the effectiveness of compensatory education programs, Ramey (1985) identified 10 programs which had randomly assigned high risk infants to experimental or control groups. The project which showed the greatest difference, The Milwaukee Project, in terms of child progress as measured by the Stanford-Binet was also the most intense.



It included day care for children, parent education and job training. From an analysis of data of three samples of high risk infants randomly assigned to treatments consisting of day care and family education, family education only, and an untreated control group, Ramey (1985) concludes that "intervention consisting of parent education alone is not an intervention of enough intensity . . .". (p. 83) Children who received day care and whose parents received family education were developmentally superior to both the family education and control group.

An innovative approach to early intervention is one which has been recently instituted at the University of Washington (Mitchell, Magyary, Barnard, Sumner & Booth, 1986). This program begins at mid-pregnancy and is designed to meet the needs of high risk families through home-based intervention. Unlike the dyadic approach commonly used in early intervention, this program uses a mental health model. Characteristics of this model include a process orientation, the nurturing of a therapeutic relationship and the provision of comprehensive health care. Based on models of maternal competence, parent-child interactions and healthy child development, the emphasis is on the process of "dealing with family problems and developmental issues". (p. 13) It is too early to evaluate the outcome of this model.

Finally, the contribution of the child's own characteristics to cognitive development in the developmentally disabled is virtually unexplored. It has been shown by Wachs(1984) that in normal youngsters the effect of the environment of cognitive functioning is a complex one. Not only does there appear to be evidence that different aspects of the environment differentially influence stages of cognitive development, depending on the age of the child, but that those influences are mediated by the characteristics of the child. In addition, there is mounting support to suggest that interactions occur between age, environment and child characteristics.

Although correlations between infant developmental tests and later intelligence have been shown to be weak for the "normal population" (Lewis, 1976). This finding has not held up for those infants who score within the retarded range within the first year. Drillien and Drummond (1977) has shown that the lower the initial assessment score, the higher the correlation with later assessment. Werner et al. (1968, 1971) have shown that the best sets of predictors of intelligence and achievement at age 10 for those whose Cattell IQ was below 80 at 20 months of age, was a combination of IQ at 20 months and pediatricians' ratings.

If there is to be understanding of the complex

influences on the cognitive development of children with developmental disabilities, major research efforts are needed employing multivariate longitudinal approaches. The independent measures which need to be included are: neurodevelopmental status; qualitative and quantitative aspects of the home environment, such as parent-child interactions, crowding, appropriateness of play materials, family resources and stresses, parental understanding of and attitude toward their child's development; and child characteristics, such as temperament and birth order.

The nature of cognitive development itself in children with developmental disabilities remains an enigma. Are certain handicapping conditions associated with specific deficits in information processing? How much can environmental influences actually ameliorate the effects of biological trauma on the developing central nervous system? Are there environmental, age, and and organismic specificities that are critical?

A first step in addressing the issues above would be to conduct systematic, serial, large scale screenings of populations, symptomatic and asymptomatic, for developmental disabilities at various points in their development. Through the use of sampling techniques, groups could be selected and matched for further in-depth investigation and longitudinal study.

APPENDIX A

Rochester Research Obstetric Scale

Code Number \_\_\_\_\_ Date of Exam \_\_\_\_\_  
 Date of Birth \_\_\_\_\_

Rochester Research Obstetrical Scale (ROS)\*

Scale	Points
<b>Prenatal</b>	
1. Young mother (primigravida < 16 yrs, multigravida < 18)	1
2. Old (> 35 yrs)	1
3. Grand multiparity (> 6)	1
4. Abortions (> 2)	1
5. Chronic medication (exclude vitamins)	1
6. Physical disorders (chronic diseases or infections, 1 pt each)	1
Prenatal score	1 2 3 4
<b>Delivery</b>	
7. C-section (planned = 1 pt, unplanned = 2 pts)	1 2
8. Induction	1
9. Premature rupture of membranes	1
10. Presentation (not vertex)	1
11. Cord (knotted, prolapsed, or tight around neck)	1
12. Placenta problem	1
13. Amniotic fluid (turbid = 1 pt, bloody = 2 pts)	1 2
14. Multiple gestation	1
15. Forceps (low = 1 pt, mid or high = 2 pts)	1 2
16. Analgesia (> 50 mg = 1 pt, > 100 mg = 2 pts)	1 2
17. Anesthesia (> local or pudental block = 1 pt, general = 2 pts)	1 2
18. Long labor (Primigravida: Stage I > 20 hrs or Stage II > 2 hrs)	1
(Multigravida: Stage I > 20 hrs or Stage II > 2 hrs)	
19. Short labor (Primigravida: Stage I < 3 hrs or Stage II < 10 mins)	1
(Multigravida: Stage I < 2 hrs or Stage II < 10 mins)	
Delivery Score	
<b>Infant</b>	
20. Birthweight low (< 2500 g) and/or premature birth	1
21. Fetal heart rate low	2
22. Neonatal heart rate (< 100)	1
23. Resuscitation necessary	1
24. Apgar at 5 min < 8	1
25. Gross physical anomaly	2
26. Fetal or neonatal death (< 30 days)	3
27. Physical disorders (1 pt each)	1 2 3
Infant score	
Total score	

\* Sameroff, A. (1979). The etiology of cognitive competence: A systems perspective. In R. B. Kearsley & I. E. Siegel (Eds.), *Infants at risk: Assessment of cognitive functioning* (p. 135). Hillsdale, NJ: Lawrence Erlbaum Associates.

APPENDIX B

Pediatrics Complications Scale

Code Number \_\_\_\_\_ Date of Exam \_\_\_\_\_

Date of Birth \_\_\_\_\_

## 4- And 9-Month Pediatric Complications Scale (PdCS)\*

Item

4 mo.      9 mo.

Normal head growth rate  
 Normal weight growth rate  
 Normal length growth rate  
 Illness  
 Injury  
 Seizure  
 Hospitalization for illness or injury  
 Hospitalization for surgery  
 Feeding difficulty  
 Abnormal crying pattern  
 Abnormal sleeping pattern

Anomaly

Craniofacial  
 Cardiopulmonary  
 Abdominal  
 Genitourinary  
 Extremity

Neurological abnormality

Eye  
 Face  
 Neck & trunk  
 Extremity

Auditory deficit

Visual deficit

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\*Littman, B. & Parmelee, A. H. (1978). Medical correlates of infant behavior. Pediatrics, 61, 472.

## APPENDIX C

### Home Observation for Measurement of the Environment



## HOME Inventory for Families of Infants and Toddlers

Bettye M. Caldwell and Robert H. Bradley

Family Name \_\_\_\_\_ Date \_\_\_\_\_ Visitor \_\_\_\_\_

Child's Name \_\_\_\_\_ Birthdate \_\_\_\_\_ Age \_\_\_\_\_ Sex \_\_\_\_\_

Caregiver for visit \_\_\_\_\_ Relationship to child \_\_\_\_\_

Family Composition \_\_\_\_\_  
(Persons living in household, including sex and age of children)Family Language Maternal Paternal  
Ethnicity Spoken Education EducationIs Mother Type of work Is Father Type of work  
Employed? when employed Employed? when employed

Address \_\_\_\_\_ Phone \_\_\_\_\_

Current child care arrangements \_\_\_\_\_

Summarize past  
year's arrangements \_\_\_\_\_Caregiver for visit \_\_\_\_\_ Other persons  
present \_\_\_\_\_

Comments \_\_\_\_\_

## SUMMARY

Subscale		Score	Lowest Middle	Middle Half	Upper Fourth
I.	Emotional and Verbal RESPONSIVITY of Parent		0-6	7-9	10-11
II.	ACCEPTANCE of Child's Behavior		0-4	5-6	7-8
III.	ORGANIZATION of Physical and Temporal Environment		0-3	4-5	6
IV.	Provision of Appropriate PLAY MATERIALS		0-4	5-7	8-9
V.	Parent INVOLVEMENT with Child		0-2	3-4	5-6
VI.	Opportunities for VARIETY in Daily Stimulation		0-1	2-3	4-5
TOTAL SCORE			0-25	26-36	37-45

For rapid profiling of a family, place an X in the box that corresponds to the raw score on each subscale and the total score.

Place a plus (+) or minus (-) in the box alongside each item if the behavior is observed during the visit or if the parent reports that the conditions or events are characteristic of the home environment. Enter the subtotal and the total on the front side of the Record Sheet.

**I. Emotional and Verbal RESPONSIVITY**

1. Parent spontaneously vocalized to child twice.
2. Parent responds verbally to child's verbalizations.
3. Parent tells child name of object or person during visit.
4. Parent's speech is distinct and audible.
5. Parent initiates verbal exchanges with visitor.
6. Parent converses freely and easily.
7. Parent permits child to engage in "messy" play.
8. Parent spontaneously praises child at least twice.
9. Parent's voice conveys positive feelings toward child.
10. Parent caresses or kisses child at least once.
11. Parent responds positively to praise of child offered by visitor.

Subtotal

**II. ACCEPTANCE of Child's Behavior**

12. Parent does not shout at child.
13. Parent does not express annoyance with or hostility to child.
14. Parent neither slaps nor spansks child during visit.
15. No more than one instance of physical punishment during past week.
16. Parent does not scold or criticize child during visit.
17. Parent does not interfere or restrict child more than 3 times.
18. At least ten books are present and visible.
19. Family has a pet.

Subtotal

**III. ORGANIZATION of Environment**

20. Substitute care is provided by one of three regular substitutes.
21. Child is taken to grocery store at least once/week.
22. Child gets out of house at least four times/week.
23. Child is taken regularly to doctor's office or clinic.
24. Child has a special place for toys and treasures.
25. Child's play environment is safe.

Subtotal

**IV. Provision of PLAY MATERIALS**

26. Muscle activity toys or equipment.
27. Push or pull toy.
28. Stroller or walker, kiddie car, scooter, or tricycle.
29. Parent provides toys for child during visit.
30. Learning equipment appropriate to age--cuddly toys or role-playing toys.
31. Learning facilitators--mobile, table and chairs, high chair, play pen.
32. Simple eye-hand coordination toys.
33. Complex eye-hand coordination toys (those permitting combination).
34. Toys for literature and music.

Subtotal

**V. Parental INVOLVEMENT with Child**

35. Parent keeps child in visual range, looks at often.
36. Parent talks to child while doing household work.
37. Parent consciously encourages developmental advance.
38. Parent invests maturing toys with value via personal attention.
39. Parent structures child's play periods.
40. Parent provides toys that challenge child to develop new skills.

Subtotal

**VI. Opportunities for VARIETY**

41. Father provides some care daily.
42. Parent reads stories to child at least 3 times weekly.
43. Child eats at least one meal per day with mother and father.
44. Family visits relatives or receives visits once a month or so.
45. Child has 3 or more books of his/her own.

Subtotal

**TOTAL SCORE**

\*For complete wording of items, please refer to the Administration Manual.

Code No. \_\_\_\_\_

APPENDIX D  
Individualized Program Plan

R.I. DEPT. OF MENTAL HEALTH, RETARDATION AND HOSPITALS  
Division of Retardation  
EARLY INTERVENTION PROGRAM

Summary of Initial or Annual  
Interdisciplinary Team Evaluation  
and  
Individual Program Plan

D.O.R. Case Number 868 Date Received in D.O.R.           

Child's Name Steven D.O.B. 9/18/83

EVALUATION SUMMARY

Date of Evaluation 3/11/85 C.A. 18 months

SUMMARY AND RECOMMENDATIONS

Steven is an 18-month-old youngster who has been involved with CDC-Early Intervention for almost one year. He was born prematurely at 25 weeks gestation and weighed 890 grams. He had multiple neonatal problems including an intraventricular hemorrhage with progressive hydrocephalus requiring shunting.

Routine pediatric care is provided by Dr. May. Follow-up for bronchopulmonary dysplasia is with Dr. Rompf. Neurosurgical and orthopedic monitoring is carried out at the CDC Neurosurgical Clinic. Debbie Darrow, R.P.T., has provided direct physical therapy weekly, but Steven is now seen only once a month. Dr. Curran has done an ophthalmological evaluation and will examine Steven again in June 1985. RI Hospital Hearing and Speech Center has conducted audiologic testing. This evaluation was conducted for the purposes of annual formal reassessment and for reestablishing baseline levels of developmental functioning in order that a habilitative home program could be redesigned. It is summarized as follows:

Many of Steven's behavioral organization skills are typical of children learning to assert their independence. Steven is very alert and socially responsive. Although Steven's visual information processing skills range up to the 16 month level, there were some indications of difficulties in following moving objects and in coordinating visual perceptual processing with fine motor coordination. Receptive and expressive language skills are in the 12 to 14 month range. Most communication, at present, is accomplished through the use of vocalizations and gestures. Steven's present

level of cognitive development is represented by an uncorrected Mental Development Index of 78 and an "attained test age" of 15.3 months. Fine and gross motor skills are currently at the 11 month level. The quality of his movement is compromised by increased tone, proximal instability, and associated responses in the right upper extremity. Steven is exploring some independence in self-care skills, especially feeding. He is still dependent in dressing.

Steven remains an appropriate candidate for the Early Intervention Program, given his diagnosis of shunted hydrocephalus. In addition to the routine services provided by EIP, Steven would benefit from direct occupational therapy on a weekly basis to address the delays in his visual perceptual motor and fine motor skill development. At this point in time, he would also benefit from physical therapy consultation in the home to focus on the gaps in skill development needed for independent ambulation.

## PROGRAM PLAN SUMMARY:

## Goals and Objectives:

TIME FRAME: 8 to 10 weeks

BEHAVIORAL ORGANIZATION

Teaching Goal #1 - To continue to encourage the development of skills important for learning.

Objective: Steven will "stay with" activities; try different approaches; ask for help when he needs it and finish.

COGNITIVE/THINKING

Continue to help Steven develop his thinking skills further by working on the activities from his last home program.

RECEPTIVE LANGUAGE

Teaching Goal #1 - To increase receptive language skills (understanding spoken language).

Objective: Steven will stop an activity when told "no".

Teaching Goal #2 - To develop understanding of action words and ability to follow directions.

Objective: Steven will show he knows what many common action words mean.

EXPRESSIVE LANGUAGE

Teaching Goal #1 - To recognize that making sounds can "get things done" (beginning communication).

Objective: Steven will make sounds to have his needs met.

Objective: Steven will use words or word approximations to have his needs met.

GROSS MOTOR

Teaching Goal #1 - To prepare Steven for independent walking.

Objective: Steven will tolerate and respond to dynamic changes in sitting positions.

Objective: Steven will crawl with rotation of the pelvis on the trunk.

Objective: Steven will refine trunk muscle use.

Objective: Steven will improve weightshifting in standing.

ACTIVITIES OF DAILY LIVING

Teaching Goal #1 - To develop independence in cup drinking.

Objective: Steven will hold and drink from a cup using two hands.

Teaching Goal #2 - To develop independence in self-feeding skills.

Objective: Steven will spoon feed himself.

Teaching Goal #3 - To use daily activities as a fun time for learning and doing.

Objective: Steven will engage in midline play while in the bath.

SERVICE TO BE PROVIDED  
Provider(s)

Schedule

CDC-Early Intervention

Program Team:  
 Psychologist,  
 Physical Therapist,  
 Occupational  
 Therapist,  
 Educator, Nurse/  
 Developmental  
 Specialist,  
 Speech/Language  
 Pathologist

- Informing Interview
- Demonstration of  
 habilitative program
- Ongoing monitoring and  
 revision of habilitative  
 program every 8 to 10  
 weeks or whenever  
 indicated
- Comprehensive annual  
 reassessments
- School planning

VNA Providence VNA

- Two times per month to  
 assist the family in the  
 implementation of the  
 home program

Other:

-Referral to be made  
 to R.I.H. Occupational  
 Therapy pending  
 parental approval

- To provide direct  
 services in order to  
 improve fine motor  
 development. Schedule to  
 be determined by treating  
 therapist

-R.I.H. Hearing &  
 Speech

- On an as needed basis to  
 monitor development of  
 hearing

GROUP CLASS PARTICIPATION

Current: No

Planned: Yes, at the Trudeau Center

PERSON(S) MEETING WITH PARENT(S) OR OTHER CARETAKERS TO  
 EXPLAIN PROGRAM

Name

Ruth Schennum, M.S.

Cinndi Lovejoy, R.P.T.

Date

4/8/85

"



Initiation of IPP: 4/8/85

PARTICIPANTS IN SERVICE PLAN

<u>Name</u>	<u>Discipline</u>	<u>Eval. Date</u>
Ruth Schennum, M.S.	Psychology	3/11/85
Cindi Lovejoy, R.P.T.	Physical Therapy	"

Conf. Date

3/11/85  
"

\_\_\_\_\_  
PARENT'S SIGNATURE

\_\_\_\_\_  
DATE

SUMMARY PREPARED BY:

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

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